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X-Ray Characterization of Quaternary Antimonide MAterials for Mid-IR Lasers

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6. AUTHORS
Luke F. Lester

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The University of New Mexico
Center for High Technology Materials
1313 Goddard SE
Albuquerque, NM 87106

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13. ABSTRACT *(Maximum 200 words)*

The new mid-IR PL/optical pumping setup has been invaluable in the study of GaInAsSb and AlInAsSb materials that are MBE grown on a GaSb substrate. A PL intensity plot vs. wavelength for GaInAsSb grown at the University of New Mexico is displayed on the last page of the report. This PL trace was generated using the equipment purchased with the grant money.
We believe that new alloys constructed from AlInAsSb and GaInAsSb will be the backbone of future antimonide-based semiconductor lasers. UNM grows the AlInAsSb using the digital alloy method. This technique employs the growth of several phase-stable alloys (binaries, ternaries, quarternaries, etc.), each a fraction of a monolayer to several monolayers thick. The net composition of these thin layers yields the desired alloy. For our work, InAs, AlSb, and InSb binaries were used to build the AlInAsSb quaternary. Whereas the research community has found that bulk growth of optical quality AlInAsSb with large Al is impossible due to a miscibility gap, UNM has recently shown that high-quality digital alloy growth of non-phase-separated AlInAsSb is possible up to 40% Al composition. One of the next steps is to determine the energy bandgaps of these materials, which as of now are unknown.

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X-Ray Characterization of Quaternary Antimonide Materials for Mid-IR Lasers

With the approval of the program manager, the equipment purchased on this grant was changed to a set of equipment suitable for photoluminescence experiments and optical pumping on mid-IR materials. This change was precipitated by the planned departure of the individual in the Principal Investigator's research group who requested the new x-ray source equipment. This individual was the only person with an intimate knowledge of high-resolution x-ray diffraction at the Center for High Technology Materials (CHTM) at the University of New Mexico (UNM). The following is a brief description of the equipment that was purchased. On the second page, photographs of the equipment in the laboratory are shown.

Liquid Nitrogen Optical Crostat: An evacuated dewar and shroud with three Calcium flouride windows from Cryo Industries. This is a cryostasis chamber where samples are mounted for testing.
2 SDL, Inc. Laser Diode Drivers: High power current source from SDL to drive the pump laser.
Detector model J10D: An InSb detector from EG&G to detector infra-red emissions.
Power Meter model EPM1000: A power meter with PM3 thermopile from Molectron to determine total emitted power.
Gold Mirrors: Two spherical mirrors from CVI to focus and direct sample emissions into the monochromator. One ellipsiodal segmented mirror from Aero Research for collecting the sample's emissions.
Temperature Controler model 330: A temperature controller for cryostat from Lakeshore with heater and silicon diode.
Fiber Bundle: A fiber bundle to direct pump light into the cryostat
Water Cooler Model RTE100: A cooler for pump laser.
IR Camera model PV320: Mid-IR camera from Electrophysics for alignment of sample emission.
Lens: Plano-Convex lens from CVI for focusing pump onto sample.

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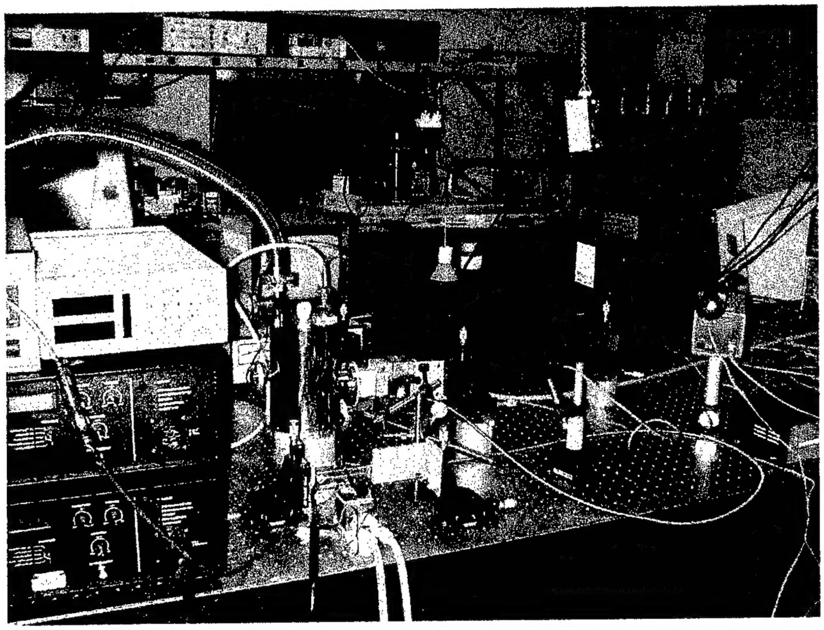

Fig. 1 The left foreground shows the black current drivers, cryostat temp. controller (white box), and the laser diode pump source assembly. The metal cylinder left of center is the cryostat, and the black box towards the back of the table is a monochromator. The IR camera for viewing and alignment is on the far right.

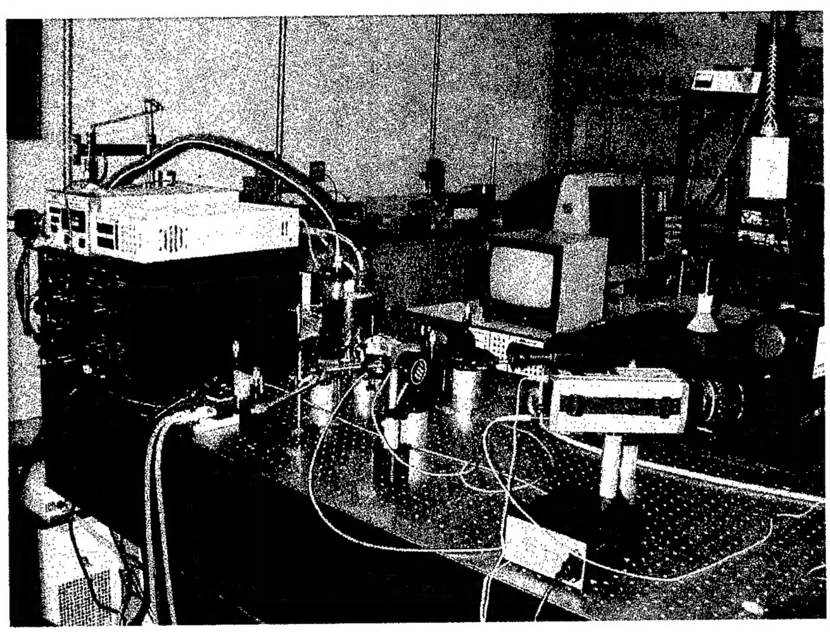

Fig. 2 Another view of the PL/optical pumping apparatus

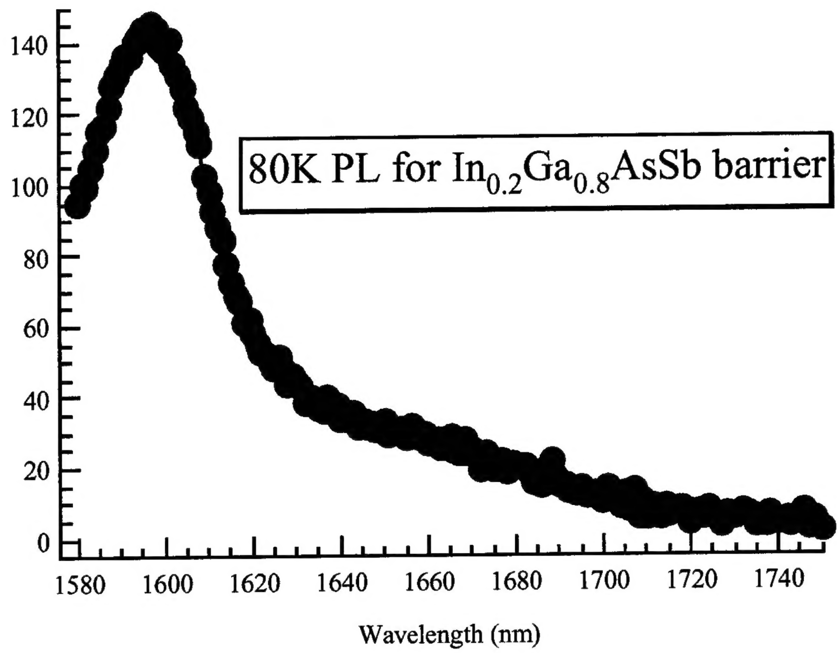

Fig. 3. PL data for a bulk GaInAsSb sample gorwn at UNM. Temperature is approximately that of liquid nitrogen.